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First record of *Pouteria franciscana* Baehni (Chrysophylloideae, Sapotaceae) in Amapá state, eastern Brazilian Amazonia

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Abstract

This is the first record of *Pouteria franciscana* Baehni (Chrysophylloideae, Sapotaceae) in Amapá state, Brazil. We provide a brief description as well as a distribution map, illustrations, and a table with useful features to distinguish *P. franciscana* from its morphologically related Amazonian species. Using geographic data and applying IUCN criteria, we assign the status as Least Concern for *P. franciscana*.

Keywords

"Abiurana", Amazonian floodplain forest, flora, new occurrence, taxonomy.

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Introduction

Sapotaceae Juss. is a pantropical woody family divided into three subfamilies: Chrysophylloideae Luerss., Sapotoideae Eaton, and Sarcospermatoideae (Lam) Swenson & Anderb. It is composed of 58 genera and about 1250 species (Pennington 1991; Govaerts et al. 2001; Swenson and Anderberg 2005; Swenson et al. 2007). Chrysophylloideae includes about 28 genera and 600 species, and it is considered the most diverse evolutionary lineage in Sapotaceae and best represented subfamily in the Neotropics (Swenson and Anderberg 2005; Swenson et al. 2008, 2013).

In Brazil, Sapotaceae is composed of 12 genera (of which nine belong to Chrysophylloideae) and approximately 230 species that occur across a wide variety of habitats, including evergreen to deciduous forests in the Cerrado, Caatinga, Amazonia, and Atlantic Forest biomes; the last two are considered the major centers of diversity for some genera of Sapotaceae (Pennington 1990, 2006; Terra-Araujo et al. 2013; Alves-Araújo et al. 2014; BFG 2015).

Pouteria Aubl. is the largest genus of Chrysophylloideae in the Neotropics, with approximately 200 known species that occur in a broad range of habitats, such as lowland rainforests on either white-sand or clayish soils throughout South America (Pennington 1990, 1991, 2006). It is highly polyphyletic with natural boundaries still unresolved (see Faria et al. 2017: fig. 2). Growing evidences demonstrate that *Pouteria* sensu Pennington (1990, 1991) is impossible to uphold (Bartish et al. 2005; Swenson and Anderberg 2005; Triono et al. 2007; Swenson et al. 2008, 2013).

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Over the past few years, new species and new occurrence records of *Pouteria* have been reported from the Brazilian Atlantic forest (Alves-Araújo and Alves 2011, 2012a, 2012b; Popovkin et al. 2016; Mônico et al. 2017; Alves-Araújo 2018; Alves-Araújo and Mônico 2018). In the highly diverse Amazonia forest (ter Steege et al. 2016), *Pouteria* is amongst the 10 top most species-rich tree genera (ter Steege et al. 2016; Cardoso et al. 2017), but still remains poorly studied in this biome.

As a result of sampling efforts, one additional *Pouteria* species is now added to the flora of Amapá state. Although *Pouteria franciscana* has a broad distribution, it is hardly found in herbaria collections, and according to Alves-Araújo et al. (2014) appears to be a rare species in the field. The new record extends the species' occurrence to extreme northern of Brazil, and provides an important contribution to our knowledge of the Sapotaceae to the still understudied Amazonian flora.

Here, we provide a brief description as well as a distribution map, illustrations, and a table with useful features to distinguish *P. franciscana* from its morphologically related Amazonian species, in addition to an informal update of its conservation status that was previously assigned as Vulnerable.

Methods

Field expeditions were conducted at the Experimental Research Station of Embrapa Amapá in Mazagão municipality, AP, eastern Amazonia, Brazil (00°06′37″S, 051° 16′35″W, at 15–18 m elev.). The area is located in the Amazonian estuary, with predominance of tidal floodplain forests (also called "várzea") classified as Alluvial Dense Ombrophilous Forest (IBGE 2012). The climate type of the region is considered Am (tropical monsoon), according to Köppen-Geiger (Alvares et al. 2013), with the following average annual values: precipitation, 2549.7 mm; temperature, 23.8–31.5 °C, and relative humidity, 82.2%. The highest rainfall occurs between January and June, and relatively less rain is observed in the other months of the year (INMET 2018). The dominant soil type is Typical Eutrophic Ta Melanic Gleysol, shallow, silty, and fertile, and it may show some level of acidity, toxicity, and deficiency of certain nutrients (Pinto 2014).

Samples of *Pouteria franciscana* were collected and deposited at IAN, INPA, HAMAB, and VIES herbaria (acronyms according to Thiers 2018). Leaves, flowers, fruits, and seeds were described using fresh material, and other morphological characteristics such as habit and bark pattern were observed in the field. The flowers were dissected and measured under a Leica stereomicroscope, model EZ4D (Wetzlar, GER). The terminology follows Pennington (1991) and Harris and Harris (2001). All morphological descriptions presented were based on a single population of this species and therefore may exhibit some variation among individuals from different populations and regions.

The known geographical distribution of *P. franciscana* and related species is based on the occurrence data obtained from labels of herbarium specimens available online at GBIF.org (2017) and SpeciesLink (2017). After downloading the collection records, we performed data screening to eliminate records with obvious georeference errors and identified and removed duplicate records by screening for unique combinations of voucher specimen, species name, latitude, and longitude. The distribution map was created using ESRI ArcGIS 10.1 software (California, USA).

The conservation status follows IUCN Red List Categories and Criteria (IUCN 2017). We imported georeferenced specimen data into the ConR package (Dauby et al. 2017) in R Program (R Core Team 2018) to calculate the area of occupancy (AOO), extent of occurrence (EOO), number of subpopulations, and number of locations. The cell size for AOO was set at 2 × 2 km.

Results

***Pouteria franciscana* Baehni**, Candollea. 9: 262 (1942) Figures 1, 2, 3

Type. Brazil: Acre: Rio Acre, Seringal São Francisco, *E.H.G. Ule 9692* (holotype, designated by Baehni 1942).

New records/material examined. BRAZIL: Amapá, Mazagão, Comunidade Furo do Mazagão, Embrapa Amapá-Campo Experimental do Mazagão, transecto 5, 00°06′39″S, 051°16′31″W, 28 Jan. 2014, *C.C. Vasconcelos et al. 2* (IAN, VIES); ibid, 00°06′38.09″S, 051° 16′ 31.98″W, 27 Feb. 2016, *J.G.L. Isacksson & M.J.J. Viana 10* (HAMAB, IAN); ibid, 00°06′39.09″S, 051°16′31.78″W, 18 Aug. 2017, *C.C. Vasconcelos et al. 159* (HAMAB, IAN, INPA); ibid, 00°06′38.16″S, 051°16′32″W, 18 Aug. 2017, *C.C. Vasconcelos et al. 160* (HAMAB, IAN, INPA); ibid, 00°06′38.95″S, 051°16′31.03″W, 18 Aug. 2017, *J.B.P. Costa et al. 81* (HAMAB, IAN, INPA).

Identification. Trees 18–26 m tall, trunk 33–80 cm dbh (diameter at breast height), generally fluted or cylindrical, buttressed (not ramified) up to 3 m high. Bark thin, pale yellow to grayish, slightly fissured or scaly, not lenticellate; inner bark light brown and pale-yellow sapwood. Latex white in all parts of plant, sticky. Twigs glabrescent, without lenticels. Leaves clustered, spirally arranged, without stipules; blades 9–32 × 3–9.7 cm, elliptic to obelliptic, chartaceous, soon glabrous, dark green adaxially, pale green abaxially; base cuneate, sometimes asymmetric; apex acuminate or acute; margin slightly revolute; venation eucamptodromous with a tendency to the development of a marginal vein, usually brochidodromous near the apex; midrib slightly raised on the upper surface; secondaries of 7–13 pairs, impressed above, slightly arcuating near the margin; intersecondaries absent; tertiary veins finely oblique, with a higher order of reticulate venation, non-areolate; petiole 1–4.6 cm long, not channeled, brownish-ferruginous tomentulose. Apical bud 1.9–4.5 mm long, conical,

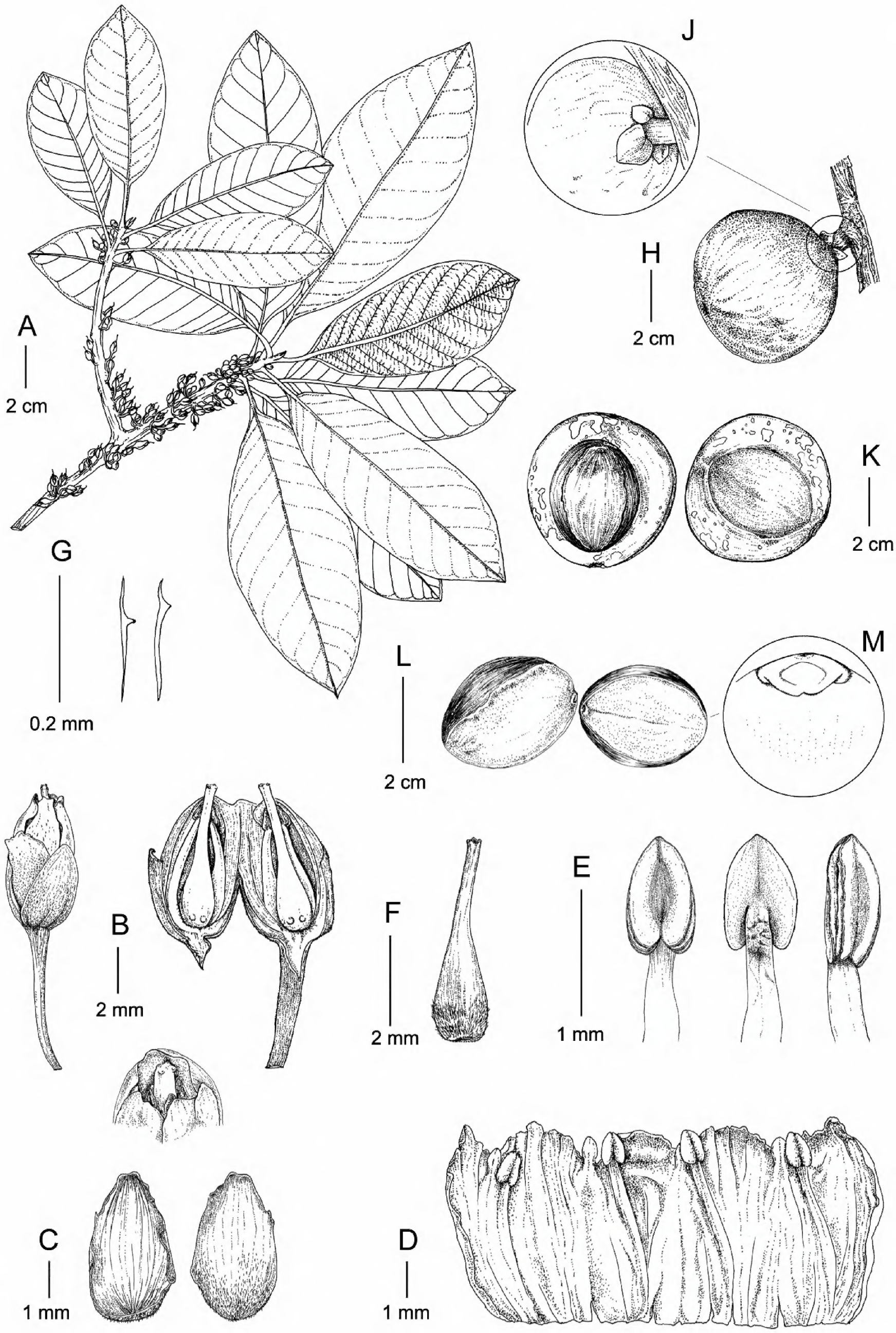

Figure 1. *Pouteria franciscana*. **A.** Floriferous branch. **B.** Whole flower, upper view and flower bud, longitudinal section. **C.** Sepals showing the inner (left) and outer (right) surfaces. **D.** Open corolla showing adnate stamens and staminodes. **E.** Stamen, adaxial (left), abaxial (middle), and lateral (right) views. **F.** Ovary and style. **G.** Malpighiaceous trichomes on flowers and leaves. **H–J.** Fruit and details of sepals. **K.** Fruit, vertical cross-section. **L.** Seed, two views. **M.** Details of the embryonic axis. (**A** from *C.C. Vasconcelos et al. 160*, **B**–**G** from *J.B.P. Costa et al. 81*, **H**–**M** from *C.C. Vasconcelos et al. 2*). Drawn by Marisabel U. Adrianzén.

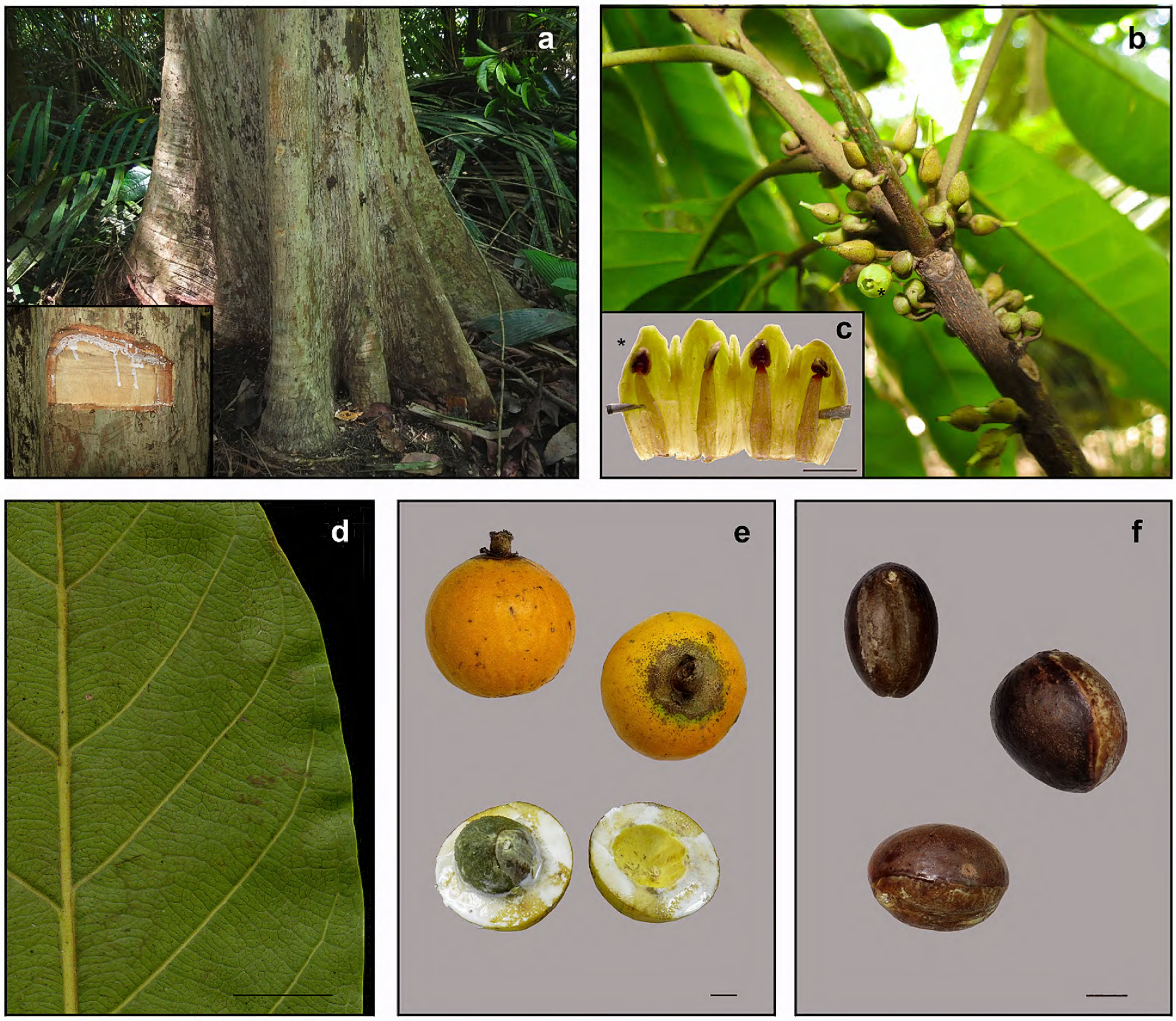

Figure 2. Field images of *Pouteria franciscana*. **A.** Buttresses and detail of bark slash. **B.** Floriferous branch showing leaf arrangement and inflorescences. **C.** Detail of open corolla showing the stamens and staminodes. **D.** Leaf venation. **E.** Fruit. **F.** Seed. Scale bars: 1 mm (**C**) and 1 cm (**D**, **E**, **F**). Photos by Janaina B. P. Costa.

brownish-ferruginous tomentulose. Flowers borne in fascicles, axillary or along the branches, 2–10 per fascicle, bisexual; pedicel 4.4–6.9 mm long, brownish tomentulose; sepals 4, 2.9–4.9 mm long (outer shorter than inner), orbicular-ovate, glabrous inside, brownish tomentulose outside, apex obtuse to acute, margin entire; corolla tubular, greenish, 3.8–6.0 mm long, sparsely strigose outside, glabrous inside; tube 5–6 mm long, 4-lobes, 2–4 mm long, orbicular, apex rounded to irregular, margin not ciliate; stamens 4, 4.8–6.6 mm long, filaments 4.2–4.6 mm long, fixed at base of the corolla tube, glabrous; anthers ca. 1 mm long, ovate, dorsifixed, extrorse and dehiscing longitudinally, glabrous; staminodes 4, 0.6–1.2, inserted between corolla lobes, lanceolate-subulate, papillate; ovary 4-locular, 0.8–1.3 mm long, ovate, whitish strigose trichomes; style 1.6–3.0 mm long, glabrous, usually exserted; stigma slightly 4-lobed. Berry, 37.1–75.7 g (fresh material), 3.8–5.0 × 4.2–5.3 cm, globoid; exocarp ca 5 mm thick, smooth, coriaceous, yellowish, usually appressed-tomentulose on surface, with lenticels brownish on apex and base; pulp fleshy, yellowish and endocarp yellow, translucent, gelatinous; fruit edible, sweet, and pleasant taste, maturing yellow or pale orange. Seed solitary, 2.6–3.4 × 2.2–2.8 cm, ovoid to ellipsoid; testa smooth, dark brownish, thin; hilum adaxial, full-length (ca 1.5 cm wide), slightly rough; embryo basal, tiny, cotyledons plano-convex, green to purple, radicle included, endosperm absent.

Phenology. The flowers were collected in August and September. The mature fruits were observed from early January. Some individuals may bear flowers and young fruits at the same time.

Distribution and conservation status. *Pouteria franciscana* has a wide distribution in South America (Fig. 3A). It occurs at least in the following 11 protected areas: Parc amazonien de Guyane, Reserva Extrativista Rio Xingu, Parque Estadual do Cristalino, Parque Indígena do Xingu, Floresta Nacional de Balata-Tufari, Reserva Extrativista Catuá-Ipixuna, Floresta Nacional de Humaitá, Área de Proteção Ambiental Igarapé São Francisco, Reserva Nacional Tambopata, and Manú National

Figure 3. A. Known geographical distribution of *Pouteria franciscana* (red circles and red star), *P. leptopedicellata* (orange circles), *P. pisquiensis* (pink circle), and *P. bilocularis* (blue circles). **B.** Location of the new occurrence record of *Pouteria franciscana* in Amapá State, Brazil.

Park. A total of 33 subpopulations (radius 5 km) of *P. franciscana* was calculated considering its entire current distribution range, with an EOO of 6,135,551 km^2, AOO of 148 km^2 (using the standard 2 km square grid), and 36 locations. In Brazil, the species shows a disjunct distribution from the Atlantic Forest (Bahia) to Amazonia forest, occurring in Acre, Amazonas, Mato Grosso, Pará, and Rondônia states (Alves-Araújo et al. 2014) and now in Amapá, especially in periodically flooded forests (Fig. 3B). Alves-Araujo et al. (2014) assigned a conservation status of Vulnerable for this species, but in Brazilian Amazonia, although *P. franciscana* has a broad distribution, it has been poorly collected and appears to be more naturally common than earlier believed. Therefore, on the basis of its presence in many protected areas and because it is usually naturally common in places where it occurs, we assigned *P. franciscana* with the status of Least Concern (IUCN 2017). However, considering some populations recorded in the "Arc of Deforestation" (an area of the east, south, and southwest of Brazilian Amazonia that suffers extensive illegal logging and agricultural expansion), and a possible reduction in habitat quality and local extinction of individuals as consequence of this (especially outside protected areas), the

threat status should be reconsidered, and we recommend that it is carefully monitored in the future.

Similar species. *Pouteria franciscana* resembles *P. pisquiensis* Baehni and *P. leptopedicellata* Pilz by the floral structure, all sharing the sparsely appressed trichomes outside the corolla (Pennington 1990). However, *P. franciscana* differs by the presence of trichomes on twigs, petioles, pedicels, sepals, and papillate staminodes (vs glabrous in *P. pisquiensis* and *P. leptopedicellata*). While these two species are confined to the Peruvian Amazonia (only known from the type), and Costa Rica and Panama, respectively (Fig. 3A), *P. franciscana* is naturally common in the Brazilian Amazonia especially in estuarine region, where is confused with *P. bilocularis* but it differs by some morphological characteristics provided in Table 1.

Discussion

During forest inventories, it is a common practice to identify tree species in the field on the basis of vegetative features by parabotanists ("mateiros"), and voucher specimens are rarely collected for comparison with herbaria or consultation with plant specialists (Hopkins and Martins-da-Silva 2003). Furthermore, ambiguous scientific names are frequently extracted from vernacular names used during fieldwork, but these names could also vary among regions and parabotanists, causing the same species to have different vernacular names or the same vernacular names are used for different species (Martins-da-Silva et al. 2003; Procópio and Secco 2008). However, in the Amazonian region, the high tree-species diversity (ter Steege et al. 2016; Cardoso et al. 2017) and poor sampling make it difficult to recognize species correctly (Hopkins 2007; Gomes et al. 2013).

In the várzea forests of the Amazon river estuary in Amapá state, most of *Pouteria*'s exploited timber species are vulgarly known as "abiurana", and this timber is used by the riverine communities for construction purposes (e.g. houses and pigsties) (Queiroz and Machado 2007). Many floristic studies carried out in this region have associated the vernacular name abiurana with *Pouteria bilocularis* (H.J.P.Winkl.) Baehni (Queiroz et al. 2005; Queiroz and Machado 2007, 2008; Carim et al. 2008). Although this species frequently appears in inventory

Table 1. Comparisons of some morphological characteristics between *Pouteria franciscana* and its morphologically related Amazonian species. Descriptions of *P. pisquiensis*, *P. leptopedicellata* and *P. bilocularis* are according to Pennington (1990).

Characters		*P. franciscana*	*P. pisquiensis*	*P. leptopedicellata*	*P. bilocularis*
Twigs	Indumentum	Glabrescent, lenticels absent	Glabrous, lenticels absent	Finely and minutely appressed puberulous or glabrous, lenticels absent	Glabrous, sometimes lenticellate
Leaf blade	Shape	Elliptic to obelliptic	Oblanceolate	Broadly oblanceolate to broadly oblong-elliptic	Elliptic to oblanceolate
	Indumentum	Glabrescent	Glabrous	Glabrous	Glabrous, usually minutely punctate above
Petiole	Shape	Not channeled	Not channeled	Not channeled	Slightly channeled
	Indumentum	Tomentulose	Glabrous	Glabrous	Glabrous
Venation	Intersecondary veins	Absent	Short or absent	Absent	Moderate to long
	Tertiary veins	Finely oblique	Horizontal to oblique	Oblique	Conspicuous, parallel to secondaries and reticulate
Flower	Color	Greenish	Whitish-green	Not mentioned	Greenish-yellow
	Merosity	4-merous	4-merous	4-merous	4–5-merous
Pedicel	Length (mm)	4.4–6.9	8–12	7–10	2–6
	Indumentum	Brownish tomentulose	Glabrous	Glabrous	Sparse minute appressed hairs or glabrous
Sepals	Length (mm)	2.9–4.9 (outer shorter than inner)	3–4	2–2.5	1–1.5
	Indumentum	Glabrous inside, brownish tomentulose outside	Glabrous	Glabrous	Sparsely appressed puberulous on both surfaces, or glabrous
Corolla	Lobes length (mm)	2–4	~2	1–1.5	Not mentioned
	Lobes indumentum (outside)	Sparsely strigose	Sparse long appressed hairs	Sparsely appressed hairy along center of lobes	Glabrous
Stamens	Insertion	At base of corolla tube	About ⅓ up corolla tube	About ⅓ up corolla tube	At top of corolla tube; absent in female flower
Filaments	Length (mm)	4.2–4.6	~2.5	~2	~0.1
Anthers	Length (mm)	1	1	0.8	0.3–0.5
Staminodes	Length (mm)	0.6–1.2	~1.5	~1	0.3–0.4
	Shape	Lanceolate-subulate	Narrowly oblong	Narrowly oblong	Ovate to subulate
	Indumentum	Papillate	Glabrous	Glabrous	Glabrous
Ovary	Locules	4-locular	4-locular	4-locular	2-locular
Style	Length (mm)	1.6–3; usually exserted	4.5–6; exserted	~4; exserted	0.4–0.5; included
Stigma		Lobed	Capitate	Lobed	Simple
Habitat		Wet lowland periodically flooded forests, 15–400 m altitude	Wet lowland forest, ~150 m altitude	Wet lowland and lower montane forests, 25–680 m altitude	Lowland rain forest over sand or clay, occasionally on periodically flooded land, ~1200 m altitude

lists, there are no recorded specimens of *P. bilocularis* in Amapá, according to the records of a local herbarium (HAMAB), a published monograph (Pennington 1990), and repositories such as SpeciesLink (2017) and Flora do Brasil 2020 (BFG 2018). However, *P. bilocularis* was reported at the border between Pará and Amapá states, more specifically in Monte Dourado (municipality of Almeirim), which is separated from Laranjal do Jari municipality only by the Jari river. In the Amazonian region, *Pouteria bilocularis* grows over sandy and clay soils in non-flooded dense "terra-firme" forests adjacent to "igapó" forests (clear-water river floodplains), the latter being one counterpart of várzea forests (white-water river floodplains) (sensu Junk et al. 2015) where *P. franciscana* is most ecologically associated.

Furthermore, collection of fertile plant material from Amazonia is difficult. For example, in a previous study performed in the floodplain forests of Amapá state (Vasconcelos 2015), morphotypes of two of the most frequent species of abiurana were compared (based on features of the trees, branches, fruits, seeds, seedlings, and germination). The specimens were not identified to the species level because the collected fertile material was not sufficient for accurate identification; thus, it was necessary to collect material with flowers. In later expeditions, flower specimens of at least for one of these morphotypes were finally collected, which allowed the recognition of *P. franciscana*, a new record from Amapá state.

In general, it is very difficult to accurately identify *Pouteria* spp. because there are a large number of species with many morphological variations and untenable limits (Swenson et al. 2007, 2008; Triono et al. 2007; Faria et al. 2017). Pennington (1990, 2006) recognized a large group of closely related and imperfectly known Amazonian species containing *P. franciscana* and others species from sect. *Pouteria* (called "group 5" by Pennington 1990: 34). According to Pennington (1990), all these species have a similar foliage and are difficult to separate when sterile. Species differences in Sapotaceae are usually seen in fruit and seed characters, but the fruit of many these species remain unknown. In the case of *P. franciscana*, the collected flowers allowed us to distinguish this species from similar species such as *P. pisquiensis* and *P. leptopedicellata* (sect. *Pouteria*) and from *P. bilocularis* (Table 1). In addition to the flowers of *P. franciscana*, we include complementary descriptions of tree bark, fruit, and seed embryo, which may be useful characters for species recognition.

A rapid query using "*Pouteria*" on the website Flora do Brasil 2020 (BFG 2018) showed a total of 26 species recorded in Amapá state to date. Even considering the low species diversity east of Amazonia (ter Steege et al. 2003), this number is still uncertain because Amapá's botanical collections remain undersampled, which highlights the importance of performing checklists for the state flora. Therefore, this new record reinforces the importance of field expeditions for botanical collections, especially in areas that are still not very well known from the floristic and taxonomic view point, such as Amapá state and the floodplain forests of the Amazonian estuary.

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Authors' Contributions

CCV, JBPC, and MCG collected the specimens from the field. CCV and JBPC herborized and described the material, and MHTA helped in the species identification. JBPC took the photographs, and CCV created the map and edited the figures. All authors wrote and discussed the manuscript.

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